NAVAL PROVING GROUND

DAHLGREN, VIRGINIA

REPORT NO. 14-44

EXAMINATION OF JAPANESE 20MM A.P. OERLIKON AMMUNITION

NAVAL PROVING GROUND CAPTURED ENEMY EQUIPMENT
REPORT NO. 86.

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APPROVED:

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PREFACE

AUTHORIZATION

Specific directives for this investigation were issued in Bureau of Ordnance ltr. EF37/A8-3(Relf) dated 27 December, 1943.

OBJECT

To make a complete physical, chemical and metallurgical examination of one round of Japanese 20mm A.P. Oerlikon ammunition, CEE No. 3448.

SUMMARY

A complete study has been made of one round of Japanese 20mm A.P. Oerlikon ammunition. The projectile is shown to be of unusual design, having a soft copper cap and a large cavity which does not carry a fuze. It appears that the sole purpose of this cavity is to bring the weight of the projectile down to the weight of other 20mm Oerlikon projectiles. The projectile has been machined from bar stock of good quality plain carbon (.45% C) steel. The cartridge case is of standard design and possesses no unusual features.

20MM A.P.
JAPANESE AIRCRAFT OERLIKON AMMUNITION
CEE No. 3448

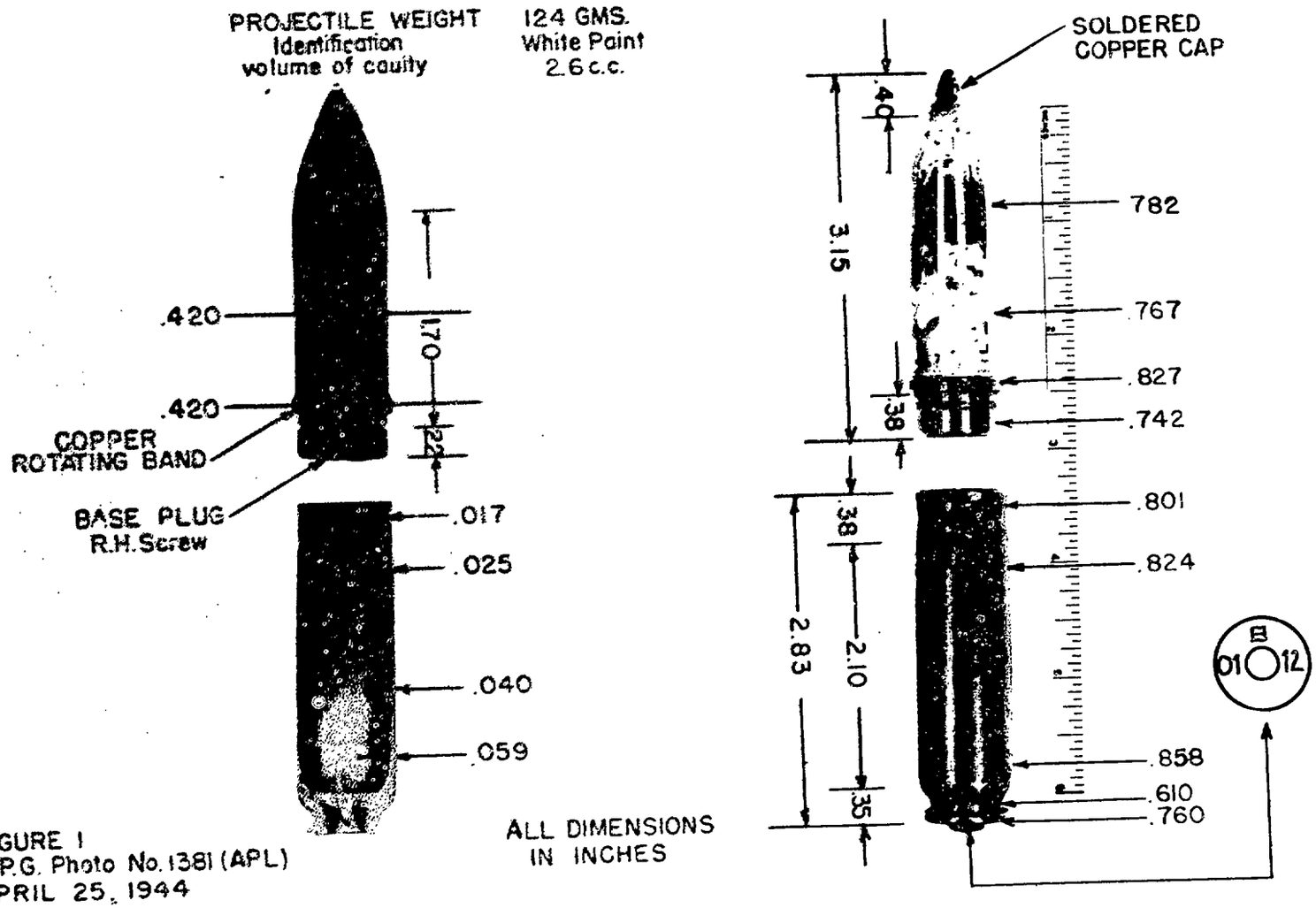

FIGURE 1
N.P.G. Photo No. 1381 (APL)
APRIL 25, 1944

ALL DIMENSIONS
IN INCHES

I. INTRODUCTION.

One complete round of Japanese Oerlikon, 20mm A.P., aircraft ammunition was received by the Armor and Projectile Laboratory for a complete physical, chemical and metallurgical examination. Since only one round was furnished no ballistic tests could be conducted.

II INVESTIGATION.

Fig. 1 shows this ammunition as received and in cross section. The cartridge case is similar to previously examined Japanese 20mm, "short case", Oerlikon cartridge cases and possesses no unusual features; the A.P. projectile is unusual in that it uses a small copper cap which is not needed for streamlining. The large cavity carries no fuze and is apparently used for the sole purpose of bringing the projectile weight down to that of other Oerlikon 20mm projectiles. The total weight of the projectile is 124 gms., which compares with 127 gms. for the H. E. and 123 gms for the H.E.I. projectiles reported on in N.O.L. sketches 70732 and 70731.

There are no identification markings other than those noted in Figure 1; the projectile is identified by white paint.

CHEMICAL ANALYSIS

Table A presents the chemical analyses of the component parts of this ammunition. The ferrous analyses are spectrochemical with the exception of carbon, phosphorus and sulphur which were made by standard wet chemical methods. Analyses could not be made on the base plug because of insufficient sample.

TABLE A

Chemical Analyses of Japanese 20mm Oerlikon A.P. Ammunition.

Projectile	C	P	S	Mn	Si	Cr	Ni	Mo
Body	.46	.031	.027	.62	.20	.06	.13	NT
Base Plug	-	--	-	.53	.28	1.25	.13	.34

	Cu	Zn	Al	Sn	Fe
Rotating Band	100				
Copper Cap	100				
Cartridge Case	70.1	29.8	.02	.001	.03

The projectile analysis corresponds closely to SAE 1045 steel, the chromium and nickel present probably entered from scrap. The analysis of the base plug is unusual in that it corresponds to steel of SAE 4100 series and represents better quality than the projectile proper. It is probable that this steel was salvaged from scrap stock; whatever the reason for such uneconomical use of alloying elements it is indicative of an economy hard pressed for manufacturing facilities.

MACROSTRUCTURE AND MANUFACTURE

The macrostructure revealed by the etch in Figure 1 shows that this projectile was machined from bar stock of clean high quality steel. The complicated contouring of the cavity was formed by a boring operation which required painstaking machining. All machining appears to be of good quality.

The cartridge case appears to have been made by conventional deep drawing of a brass disc. It possesses no unusual features.

MICROSTRUCTURE AND HEAT TREATMENT

Figure 2 shows the etched cross section of this projectile together with the microstructures and hardness of representative sections. From this data it appears that the projectile was given the following heat treatments:

(1) Austenitized, quenched and tempered to a uniform spheroidal structure. (Structure of base.)

(2) Nose dipped into a molten metallic bath to approximately half way along the cavity and held untill all of the nose section was austenitized.

(3) Nose quenched to slightly above the bourrelet.

(4) Stress relieved by tempering at a low temperature.

MICROSTRUCTURE OF JAPANESE 20MM A.P. PROJECTILE

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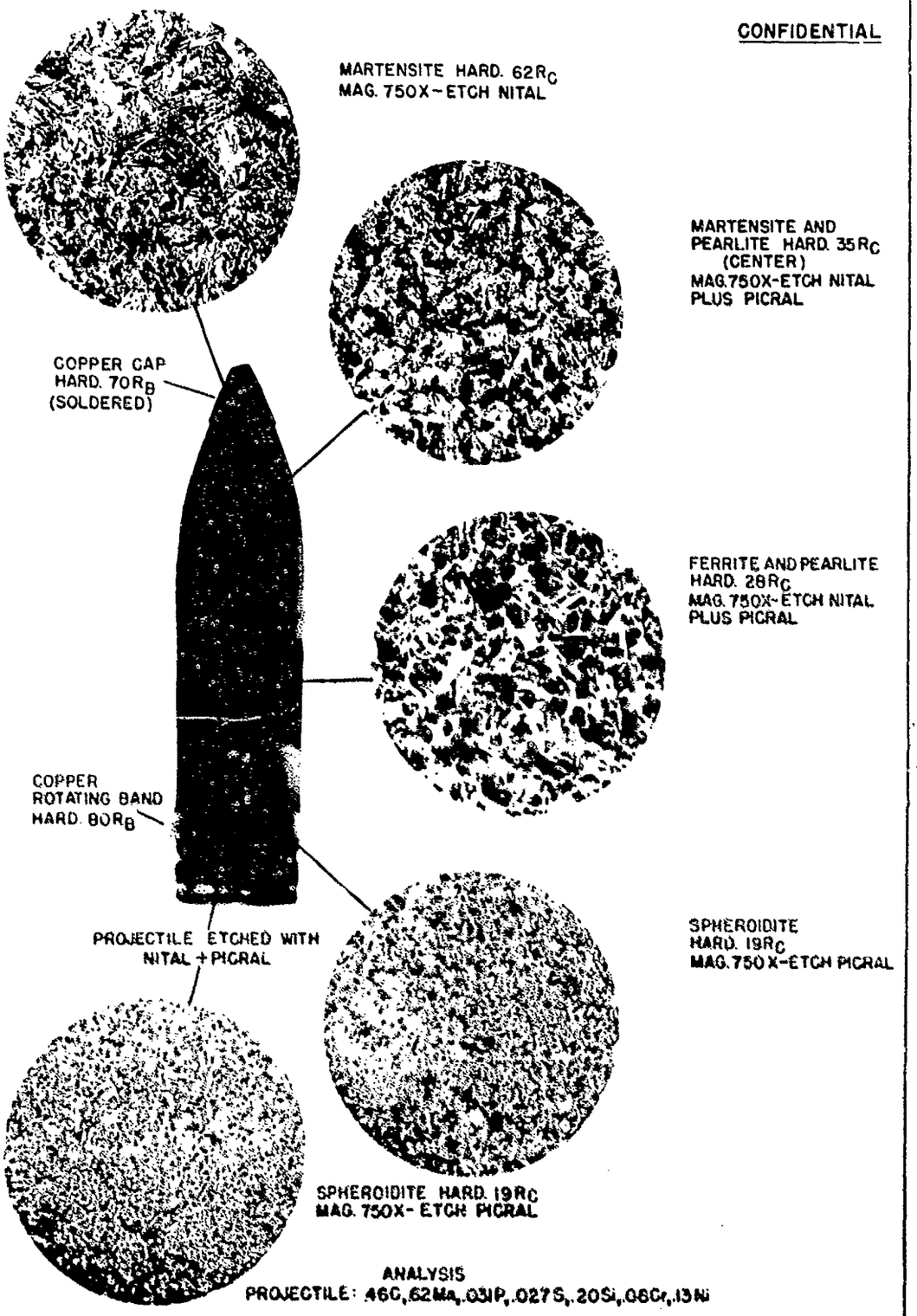

ANALYSIS
PROJECTILE: .46C, .62Mn, .03P, .027S, .20Si, .06Cr, .15Ni

FIGURE 2

NPG Photo No. 1565
APRIL 6, 1944

These series of treatments produced a projectile with a hard martensitic nose and a center partially transformed to martensite and pearlite. The mod-body section, which was austenitized but not quenched, transformed to a pearlite plus ferrite aggregate. The base section (and base plug) are in a soft, uniformly spheroidized condition.

The non-uniform appearance of the hardened zone in the nose section is due to non-uniform quenching of the nose following the nose dip. The cause for this may have been either the presence of scale or the adherence of metal from the bath, serving to hinder the quench at these points. The presence of a pearlitic region at mid-body is considered to be detrimental to the ballistic quality of this projectile. This structure could have been prevented by a complete quench of the projectile.